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Acronyms

AMA	Analysis of Material Approaches
AoA	Analysis of Alternatives
DCD	Directorate of Combat Development
FAA	Functional Area Analysis
FNA	Functional Needs Analysis
FSA	Functional Solution Analysis
G/ATOR	Ground/Air Task Oriented Radar
GWLR	Ground Weapon Locator Radar
ICD	Initial Capabilities Document
JCIDS	Joint Capabilities Integration Development System
JROC	Joint Requirements Oversight Council
MMR	Multi-Mission Radar
MNS	Mission Need Statement
MRRS	Multi-Role Radar System
PIA	Post Independent Analysis

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
400 ARMY NAVY DRIVE
ARLINGTON, VIRGINIA 22202–4704

December 14, 2006

MEMORANDUM FOR AUDITOR GENERAL, DEPARTMENT OF THE ARMY
NAVAL INSPECTOR GENERAL

SUBJECT: Report on the Requirements Process for the Army Multi-Mission Radar and the Marine Corps Multi-Role Radar System (Report No. D-2007-033)

We are providing this report for information and use. No written response to this report was required and none was received. Therefore we are publishing this report in final form.

We appreciate the courtesies extended to the staff. Questions should be directed to Mr. Harold James at (703) 604-9088 (DSN 664-9088). The team members are listed inside the back cover. See Appendix C for the report distribution.

By direction of the Deputy Inspector General for Auditing:

Richard B. Jolliffe
Assistant Inspector General
Acquisition and Contract Management

Department of Defense Office of Inspector General

Report No. D-2007-033 **December 14, 2006**
(Project No. D2006-D000AE-0150.000)

The Requirements Process for the Army Multi-Mission Radar and the Marine Corps Multi-Role Radar System

Executive Summary

Why You Should Read This Report. This report discusses the processes the Army and the Marine Corps used to generate requirements for the Multi-Mission Radar and the Multi-Role Radar System.

Background. We performed this audit in response to allegations made to the DoD Hotline. The allegations concerned the processes the Army and the Marine Corps used to generate requirements for the Multi-Mission Radar and the Multi-Role Radar System, which are both multiple-mission radar systems. This report addresses the four allegations made concerning:

- defining threat requirements and the urgent need for the radars;
- performing an adequate analysis of alternatives for the radars, to include an assessment of current radar systems, upgrades to current radar systems, and planned radar systems of the other Services;
- considering combat effectiveness and suitability factors when defining radar requirements; and
- threatening improper personnel actions against staff wanting to discuss alternative means of meeting radar requirements.

Results. We did not substantiate the four DoD Hotline allegations concerning the processes the Army and the Marine Corps used to support starting acquisitions of the Multi-Mission Radar and the Multi-Role Radar System. Since the DoD Hotline received the allegations in September 2004, the Army and the Marine Corps have continued to adhere to processes prescribed in the Joint Capabilities Integration Development System to define requirements for the Army Multi-Mission Radar and the Marine Corps Multi-Role Radar System. The Army Directorate of Combat Development had not developed an analysis of alternatives because the Multi-Mission Radar was in the pre-concept refinement phase of the acquisition process and early in the Joint Capabilities Integration Development System process. The Marine Corps performed an adequate analysis of alternatives to support the Multi-Role Radar System as part of the Ground/Air Task Oriented Radar program. Both the Army and the Marine Corps also adequately considered combat effectiveness and suitability in defining capability requirements for the radar systems. Additionally, we found no evidence that senior management had threatened the employees developing requirements for the Multi-Mission Radar and the Multi-Role Radar System. To avoid duplication of acquisition efforts, the Acquisition Executives for the Army and the Navy and members of the Army-Marine Corps Board

have discussed the potential for a joint acquisition program to satisfy multiple-mission radar requirements for both Services. While the Army and the Marine Corps do plan to further consider a joint acquisition effort, key differences in performance parameters for radar range and transportability had so far prevented them from forming a joint acquisition program.

Management Comments. We provided a draft of this report on October 19, 2006. No written response to this report was required. Therefore, we are publishing this report in final form.

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Background

We performed this audit in response to allegations made to the DoD Hotline. The allegations concerned the processes the Army and the Marine Corps used to generate requirements for the Multi-Mission Radar (MMR) and the Multi-Role Radar System (MRRS), which are both multiple-mission radar systems. This report addresses the four allegations made concerning:

- defining threat requirements and the urgent need for the radars;
- performing an adequate analysis of alternatives (AoA) for the radars, to include an assessment of current radar systems, upgrades to current radar systems, and planned radar systems of the other Services;
- considering combat effectiveness and suitability factors when defining radar requirements; and
- threatening improper personnel actions against staff wanting to discuss alternative means of meeting radar requirements.

DoD Process for Determining Weapon System Requirements. Chairman of the Joint Chiefs of Staff Instruction 3170.01E, "Joint Capabilities Integration and Development System," May 11, 2005, defines the process DoD uses to identify, assess, and prioritize joint military capability needs. The Joint Capabilities Integration and Development System (JCIDS) process begins with the top-down capabilities identification methodology, which occurs before the start of the Defense acquisition management process. The top-down capabilities identification methodology is a capabilities-based assessment composed of a structured, four-step process that draws on the expertise of all Government agencies to identify improvements to current and new warfighting capabilities. The four-step process allows the Chairman of the Joint Chiefs of Staff, with the assistance of the Joint Requirements Oversight Council (JROC), to assess and provide advice regarding warfighter capability needs for potential Defense acquisition programs. In addition, the top-down capabilities identification methodology and subsequent JCIDS processes were established to prevent redundant acquisition efforts that do not improve the warfighters' capabilities. Appendix B provides details on how DoD uses the top-down capabilities identification methodology to support starting the acquisition management process.

Multiple-Mission Radars. The Army and the Marine Corps are developing ground-based radars capable of performing multiple missions, either simultaneously or separately, without requiring hardware additions or physical reconfiguration. These missions include air surveillance, air defense, counter-battery, and air traffic control. The radars in the air surveillance mission identify and track cruise missiles, fixed- and rotary-wing aircraft, and unmanned aerial vehicles. The radars in the air defense mission provide other Service weapon systems with radar data needed to shoot down enemy cruise missiles and air-breathing threats. The radars in the counter-battery mission identify and track enemy rockets, artillery, and mortars for unit use in determining firing positions

and impact areas. The radars in the air traffic control mission track aircraft to allow air comptrollers to prevent collisions and to ensure orderly and expeditious flow of air traffic.

Army Multi-Mission Radar. The MMR capability is still in the JCIDS process and the Army is in the process of completing the top-down capabilities identification methodology. The JCIDS process is preliminary to the Army designating the MMR as an acquisition program and assigning it an acquisition category. As envisioned, the MMR will provide multifunctional radar information to support air surveillance, air defense, counter-battery, and air traffic control missions. Additionally, the MMR will support intelligence requirements through the development of a common operational picture for the Future Combat Force. The Army Directorate of Combat Development (DCD), the sponsor office responsible for the preparation of the documents required in the JCIDS process, had completed the first JCIDS document, the Functional Area Analysis (FAA), on March 6, 2006. Additionally, DCD had drafted the three documents that follow the FAA in the JCIDS process: the Functional Needs Analysis (FNA), the Functional Solution Analysis (FSA), and the Initial Capabilities Document (ICD). Appendix B provides details on the purpose and contents of these JCIDS documents.

Marine Corps Multi-Role Radar System. On July 20, 2004, the JROC approved the operational requirements document for the MRRS. The Marine Corps was developing the MRRS as part of the Ground/Air Task Oriented Radar (G/ATOR) program, which is a single material solution to meet MRRS and Ground Weapon Locator Radar (GWLR) requirements. The Marine Corps is developing the G/ATOR program as an evolutionary acquisition with four incremental development and production blocks, referred to as Increments I through IV. Each increment will have separate acquisition milestone decisions. Increment I will support two missions: air surveillance and air defense. Increment II will address the counter-battery mission. Increment III will incorporate tactical enhancements of the air surveillance and air defense missions. Increment IV will address support of the air traffic control mission.

Multi-Role Radar System Missions. The MRRS, Increment I and Increment IV of the G/ATOR program, will meet the Marine Corps requirements for a lightweight, expeditionary, three-dimensional radar capable of performing the air defense, air surveillance, and air traffic control missions. On August 26, 2005, the Assistant Secretary of the Navy (Research, Development, and Acquisition) approved the program start for Increment I of the G/ATOR program and entry in the system development and demonstration phase of the acquisition process.

Ground Weapon Locator Radar Mission. The GWLR will meet the Marine Corps requirements for the counter-battery mission. On June 1, 2005, the JROC approved the "Ground Weapons Locator Radar Capabilities Development Document, Annex A to the Multi-Role Radar System Operational Requirements Document," including the validation of its key performance parameters. The GWLR is Increment II of the G/ATOR program. The Marine Corps plans to start Increment II in FY 2009.

Objective

Our overall audit objective was to evaluate allegations from the Defense Hotline regarding the adequacy of the processes the Army and the Marine Corps were using to support starting acquisition of the Army MMR and the Marine Corps MRRS programs. Specifically, we evaluated whether the Army and the Marine Corps adequately defined threat requirements, analyzed and considered other alternatives, and supported the urgency for developing the radar systems in the near term. See Appendix A for a discussion of the scope and methodology.

Review of Internal Controls

Army and Marine Corps processes used to generate requirements for the MMR and the MRRS included adequate internal controls as they applied to the audit objectives.

Allegations Concerning the Army and Marine Corps Developing Requirements for Separate Multiple-Mission Radars

We did not substantiate the four DoD Hotline allegations concerning the processes the Army and the Marine Corps used to support starting acquisitions of the MMR and MRRS. Since the DoD Hotline received the allegations in September 2004, the Army and the Marine Corps have continued to adhere to processes prescribed in the Joint Capabilities Integration Development System to define requirements for the Army MMR and the Marine Corps MRRS. The Army DCD had not developed an AoA because the MMR was in the pre-concept refinement phase of the acquisition process and early in the JCIDS process. The Marine Corps performed an adequate AoA to support the MRRS as part of the G/ATOR Program. Both the Army and the Marine Corps also adequately considered combat effectiveness and suitability in defining capability requirements for the radar systems. Additionally, we found no evidence that senior management had threatened the employees developing requirements for the MMR and the MRRS. To avoid duplication of acquisition efforts, the Acquisition Executives for the Army and the Navy and members of the Army-Marine Corps Board have discussed the potential for a joint acquisition program to satisfy multiple-mission radar requirements for both Services. While the Army and the Marine Corps do plan to further consider a joint acquisition effort, key differences in performance parameters for radar range and transportability had so far prevented them from forming a joint acquisition program.

Allegations

The complainant made the following four allegations concerning the processes that the Army and the Marine Corps used to support starting acquisitions of the MMR and the MRRS.

- The Army and the Marine Corps did not adequately define threat requirements and the urgent need for the new radar systems.

- The Army and the Marine Corps did not perform an adequate AoA for the radars, including an assessment of current radar systems, upgrades to current radar systems, and planned radar systems of the other Service that contained nearly identical performance requirements.

- The Army and the Marine Corps did not adequately consider combat effectiveness and suitability factors for new radar systems. Specifically, the Services required the MMR and the MRRS to have liquid cooling, making them susceptible to failures from minor combat damage.

- Senior Army and Marine Corps personnel threatened retaliation, reprimand, and loss of promotion opportunity for staff wanting to discuss alternative means for meeting radar requirements.

Threat Requirements and Urgent Need

Allegation 1. The complainant alleged that the Army and the Marine Corps did not adequately define threat requirements and the urgent need for the new radar systems.

Audit Results. We did not substantiate the allegation. The Army and the Marine Corps implemented processes to adequately define threat requirements and the urgent need for the new radar systems.

Army Threat Requirements. Because the Army just started the JCIDS process for the MMR, completion of a system threat assessment was not yet required. However, the Army DCD had begun to define threat requirements for the MMR. Specifically, the draft FNA identified radar capability gaps against current and future threats. In addition, the Defense Intelligence Agency prepared an "Initial Threat Warning Assessment," December 1, 2005, for the MMR that identified projected adversarial threat capabilities that would affect the MMR design and implementation.

Draft Functional Needs Analysis. In the draft FNA, the Army DCD stated that the MMR will be required to track a large number of threats to avoid fratricide and that the inherent flexibility of the MMR was a critical capability the Army needed to offset threats. While the draft FNA primarily discussed threats in a general manner, it did discuss five critical gaps. Specifically, existing Army radars:

- lacked multi-mission functionality and the capacity to rapidly switch between mission modes;

- were unable to detect, track, and shoot down all threats at extended ranges within 360 degrees;

- lacked the capability to detect and precisely locate the full spectrum of indirect fire locations at extended ranges for the counter-battery mission;

- were incapable of accurately predicting the impact points for the counter-battery mission; and

- were incapable of classification, characterization, and positive identification of aerial objects at high levels of accuracy and assurance.

Initial Threat Warning Assessment. The Army did request the Defense Intelligence Agency to prepare an Initial Threat Warning Assessment for the MMR as required in Chairman of the Joint Chiefs of Staff Manual 3170.01B, "Operation of the Joint Capabilities Integration and Development System," May 11, 2005. In the Initial Threat Warning Assessment, the Defense Intelligence Agency identified adversarial threats that could affect a multiple-mission radar capability. The Initial Threat Warning Assessment also identified actions that adversaries could use to degrade or disrupt the operations, such as threats to radars or radar platforms and threats to the associated communications, command, control, and computer networks. Threats identified included rocket-propelled grenade launchers, anti-material agents, unmanned aerial vehicles, and lasers.

Army Urgent Need. The Army did adequately define the urgent need for the MMR. The draft FNA identified four current and critical gaps in detecting and locating existing medium caliber artillery. Additionally, the "Future Combat Systems[1] Operational Requirements Document," January 31, 2005, which the JROC validated, stated that the MMR should be capable of simultaneously performing the air surveillance, air defense, counter-battery, and air traffic control missions for the Brigade Combat Team[2] between 2017 and 2020. Further, the Deputy Director for DCD stated that developing a multiple-mission radar would decrease existing operation and support costs because a single radar rather than multiple radars would lower logistical support costs and maintenance requirements.

Marine Corps Threat Requirements. Similarly, the Marine Corps adequately defined threat requirements for its new multi-role radar system. In the JROC-approved operational requirements document for the MRRS dated July 20, 2004, the Marine Corps identified the key performance parameters for the MRRS and adequately defined the current and near future threats as established in the Marine Corps System Threat Assessment Report. It also requires the MRRS to be a lightweight, expeditionary, three-dimensional radar capable of detecting cruise missiles, fixed- and rotary-wing aircraft, and unmanned aerial vehicles.

In the "Air Combat Threat Environment Description [the Threat Environment Description]," February 2002, the National Air Intelligence Center presents a description of the threat environment that could confront U.S. Air Combat Command assets. Specifically, the Threat Environment Description discussed the current-to-20-year threat projections of cruise missiles, fixed- and rotary-wing

[1] The Future Combat Systems is composed of a family of advanced, networked, air- and ground-based sustainment systems that will include manned and unmanned platforms. The Future Combat Systems will operate as a system of systems that will network with existing capabilities and those developed to meet the needs of the Brigade Combat Team.

[2] The Brigade Combat Team, beginning in 2008, will consist of three combined arms battalions and their attached support and fire units. The Army plans for the MMR to serve as the Brigade Combat Team radar.

aircraft, and unmanned aerial vehicles. The G/ATOR program, with MRRS, will develop capabilities for assisting in countering and eliminating those threats.

In the "Marine Tactical Command and Control System (1992-2010) System Threat Assessment Report [the System Threat Assessment]," December 16, 1992, the Marine Corps evaluated current and projected threats to the Marine Tactical Command and Control System. The System Threat Assessment was still relevant because it also addresses existing threats identified in the Threat Environment Description that specifically relate to the G/ATOR mission. The G/ATOR radars directly support the Marine Tactical Command and Control System through the Marine Air Traffic Control Detachment and the Tactical Air Operations Center.

The System Threat Assessment identified 11 threats to the Marine Tactical Command and Control System, including: air strikes, guided missiles and rockets, artillery and mortars, mines, chemical and biological weapons, electronic warfare, nuclear weapons, directed energy weapons, small arms and crew-served weapons, computer threats, and anti-radiation homing weapons. The MRRS Operational Requirements Document and GWLR Capabilities Development Document identified three of those threats that the G/ATOR will counter: air strikes, guided missiles and rockets, and artillery and mortars.

The G/ATOR program, with MRRS, will assist in countering and eliminating the threat from fixed- and rotary-wing aircraft. The System Threat Assessment identified fixed- and rotary-wing aircraft as existing threats to the Marine Air Ground Task Force. It stated that those aircraft could be armed with aircraft cannon and carry free-fall bombs, cluster bombs, rockets, and guided munitions.

Marine Corps Urgent Need. The Marine Corps did adequately define the urgent need for the MRRS. In the "Mission Need Statement [MNS] for Multi-Role Radar," March 27, 1996, the Marine Corps identified the deficiencies in existing capabilities and opportunities to provide new capabilities. The G/ATOR will address the deficiencies and provide new capabilities in FY 2011.

The MNS states that the MRRS will provide radar coverage to the Marine Air Command and Control System to maintain battlefield situational awareness, exercise command and control, and engage hostile threats. The MRRS requirements correspond to capability gaps in the Marine Air Ground Task Force's ability to detect, track, and positively identify fixed- and rotary-wing aircraft and cruise missiles as outlined in the Marine Corps Mission Area Analyses 32 and 35, both dated August 26, 1994. The Military Services conduct mission area analyses to identify operational requirements and deficiencies across a broad range of functional areas.

Analysis of Alternatives

Allegation 2. The complainant alleged that the Army and the Marine Corps did not perform an adequate AoA for the radars, to include an assessment of:

- current radar systems,

- upgrades to current radar systems, and

- planned radar systems of the other Service that contained nearly identical performance requirements.

Audit Results. We did not substantiate the allegation. The Army DCD had not developed an AoA because the MMR was so early in the JCIDS process that it was not yet required. The Marine Corps performed an adequate analysis of current radar systems and upgrades to existing fielded systems to support developing the MRRS as part of the G/ATOR program. The Marine Corps did not include the Army MMR in the "Multi-Role Radar System Analysis of Alternatives," September 16, 2002, because the Army had not yet validated a system requirement for the MMR.

Army Analysis of Alternatives. DoD Instruction 5000.2, "Operation of the Defense Acquisition System," May 12, 2003, states that the milestone authority approves the plan for conducting an AoA at the concept decision point of the acquisition process. In the case of the MMR, the program sponsor was taking actions to comply with Chairman of the Joint Chiefs of Staff Instruction 3170.01E requirements that are due before the concept decision. In that respect, the draft FSA that the program sponsor prepared did examine numerous alternatives to close the identified capability gaps. In addition, the Army hired an independent contractor to study the potential costs and benefits of various radar concepts.

Draft Functional Solutions Analysis. The program sponsor drafted an FSA using the results of three sequential efforts:

- performing an analysis of doctrine, organization, training, material, leadership and education, personnel, and facilities to determine whether non-material solutions could fill the gaps;

- developing ideas for material approaches; and

- developing an analysis for material approaches (AMA) to recommend the most feasible approaches to close the gaps.

In the AMA, the program sponsor evaluated the feasibility of three options for material approaches.

- The first option included an evaluation of 13 domestic radar systems for potential upgrades to meet the MMR capability requirements. These systems included air surveillance and air defense radars, counter-battery radars, air traffic control radars, and the G/ATOR. Of the two most suitable solutions, one would require modifications to the radar equating to developing a new system without achieving all of the MMR requirements. The other solution, the Marine Corps G/ATOR, offered at least twice the range, but required more manpower; was less mobile and transportable; and was projected to cost more than twice that of the MMR capability.

- The second option included an evaluation of eight foreign ground-based radar systems to meet the MMR capability requirements. These systems included multi-mission radars and counter-battery radars. Only two of the eight radars had the potential to meet MMR requirements. The first radar would provide improved performance, but would require expensive reductions in size and weight to meet Army C-130 deployability requirements. Further discussion of the C-130 deployability requirements is included under "Deployability" in Allegation 3. The other radar met the Army C-130 deployment requirements, but would require expensive upgrades to address considerable capability shortfalls.

- The third option was an evaluation of the development of a new ground-based radar system. The program sponsor based this option on the results of an MMR science and technology objective demonstration initiated in 2002 to show the feasibility of developing the MMR. The demonstration addressed radar requirements for the air surveillance, air defense, counter-battery, and air traffic control missions. The radar in the demonstration exceeded the performance capabilities of the radars in options one and two. For example, the radar developed for the MMR science and technology objective demonstration had double the range of the Army counter-battery radar and the capability to track 10 times more targets than the Army counter-battery and air surveillance radars.

Independent Radar Review. The Army independent contractor prepared its study, "Analysis of Battlefield Radars for the Future Force Unit of Action,"[3] on February 25, 2004. The contractor studied the potential costs and benefits of various radar concepts. In this analysis, the contractor included the following alternative radar concepts for the Brigade Combat Team:

- the MMR developed under the science and technology objective demonstration;

- a counter-battery radar and the MMR developed under the science and technology objective demonstration;

- an air surveillance and air defense radar, and a counter-battery radar;

- the Marine Corps G/ATOR; and

- an air surveillance and air defense radar, and a foreign counter-battery radar.

In the study, the contractor observed that the MMR developed under the science and technology objective demonstration detected air targets at greater ranges than the existing air surveillance and air defense radars, but not at greater ranges than the G/ATOR. Further, the contractor concluded that the MMR science

[3] The Future Force Unit of Action has been changed to the Brigade Combat Team.

and technology objective demonstration and the G/ATOR in combination would have greater reliability and be easier to maintain than the fielded air surveillance and air defense radars.

Marine Corps Analysis of Alternatives. The Marine Corps study team performed an adequate AoA that addressed existing radar systems and upgrades to fielded systems. The Marine Corps used the AoA to determine the best material solution to satisfy the Marine Corps operational requirements for a lightweight, highly mobile, three-dimensional radar. The study team identified and compared four alternative material solutions to satisfy operational requirements: baseline radar systems, a non-developmental item, and s-band and x-band MRRS.[4]

Baseline Radar Systems. The baseline alternative included two legacy systems: an air surveillance and air defense radar. In addition, the baseline alternative also included a developmental air traffic control radar. The Marine Corps expected that the air traffic control radar would be developed before introducing the MRRS, and therefore identified it as legacy system for the baseline alternative.

Non-Developmental Items. The non-developmental item alternative included upgrades to two fielded radar systems and one radar system in development. Specifically, this alternative included pre-planned product improvements to a fielded air surveillance and air defense radar for the short-range air defense cueing mission. It also included the air surveillance radar from the baseline alternative, but with a proposed upgrade for increased operational reliability. This alternative also contained the air traffic control radar in development from the baseline radar alternative.

S-Band and X-Band MRRS. The s-band and x-band MRRS alternatives were the material development of new radar systems. The AoA stated that the new radar systems could perform all three of the required MRRS missions. Therefore, the new radar systems represented the capabilities proposed by various MRRS science and technology objective demonstration competitors for each of the frequency bands.

The AoA study team used a value model with 51 value attributes to evaluate the operational effectiveness and suitability of the 4 alternative solutions and to conduct a sensitivity analysis of each alternative. Stakeholders participating in the conduct of the AoA assigned a relative importance weight to each of the value attributes. Using the value model, the study team determined a single overall utility or value score for each alternative.

The s-band and x-band MRRS alternatives had value scores that were approximately two times higher than that of the baseline radar systems and non-developmental item alternatives and scored the same or better than the other alternatives on almost every value attribute. The attributes where the s-band and

[4] The s-band and x-band represent different radar bandwidths. The s-band operates at a lower bandwidth, providing a greater range of detection and operating better in inclement weather. The x-band operates at a higher bandwidth, providing more precision in identifying specific targets.

x-band scored higher included transportability, target detection capability, and mean-time-to-repair. In the area of transportability, for example, the non-developmental item alternatives required more vehicles to transport the radars in comparison to the s-band and x-band radar alternatives because it consisted of three radar systems rather than one radar system for the s-band and the x-band radar alternatives. The s-band alternative outperformed the x-band alternative in general areas of detection range, detection altitude, and reliability. However, the x-band countered these attributes with higher performance in classifying threats and tracking targets. This resulted in differences between the value scores of the s-band and x-band MRRS alternatives of less then one percent. The Marine Corps has not yet selected which radar type will be used to meet the G/ATOR requirements. The Marine Corps will make the radar type determination at contract award for the G/ATOR.

Combat Effectiveness and Suitability

Allegation 3. The complainant alleged that the Army and the Marine Corps did not adequately consider combat effectiveness and suitability factors for new radar systems. Specifically, the Services required the MMR and the MRRS to have liquid cooling, making them susceptible to failures from minor combat damage.

Audit Results. We did not substantiate the allegation. The Army DCD did consider combat effectiveness and suitability factors for the MMR in assessing all potential radar designs. Further, the Marine Corps considered the combat effectiveness and suitability factors for the MRRS and the GWLR.

Army Consideration of Combat Effectiveness and Suitability Factors. The Army considered combat effectiveness and suitability factors in the draft ICD for the MMR, as well as in the MMR developed for the science and technology objective demonstration. The draft ICD identified the required capabilities that would enable the Brigade Combat Team to achieve offensive, defensive, stability, and support operations in any terrain and environmental conditions against the full spectrum of aerial and fire support threats. The draft ICD for MMR contained combat effectiveness and suitability requirements for deployability, agility and versatility, maneuverability and mobility, survivability, and sustainability.

Deployability. The MMR must have a level of deployability commensurate with that of the Brigade Combat Team. Specifically, the MMR must have the ability to be moved with its essential combat load by a C-130 profile aircraft in accordance with the Future Combat Systems operational requirements document.

Agility and Versatility. The MMR must be a multi-functional, single, highly versatile radar capable of supporting the air surveillance, air defense, counter-battery, and air traffic control missions, while providing intelligence surveillance and reconnaissance data.

Maneuverability and Mobility. The MMR must have mobility commensurate with the Brigade Combat Team. Specifically, the MMR must be capable of traveling at off-road tactical speeds of 50 kilometers per hour and hard-surface road speeds of 90 kilometers per hour.

Survivability. The MMR must have a level of survivability that allows operations with the Future Combat Systems. To accomplish this, the MMR solution must be:

- capable of rapid acceleration survivability dashes;
- able to operate in biological, chemical, radiological, and nuclear environments without degrading radar performance;
- hardened against directed-energy, high-power microwave, and thermobaric weapons;
- able to survive an electromagnetic pulse;
- resistant to electronic tampering, electronic attack, and anti-radiation missile engagement; and
- able to reduce the probability of detection, intercept, templating, and targeting by hostile systems.

Sustainability. The MMR will have sustainability commensurate with the Future Combat Systems. The MMR must provide reliability and availability, reduced maintenance costs, built-in test equipment capable of accurately locating faults and reporting the data failure, and compatibility with the Army two-level maintenance system.

For the MMR developed through the science and technology objective demonstration, the Director, DCD required the contractor not to use a liquid cooling system because an earlier liquid-cooled radar consistently had maintenance problems. Accordingly, for the MMR demonstration the contractor used an air-cooled system.

Marine Corps Consideration of Combat Effectiveness and Suitability Factors. The Marine Corps evaluated combat effectiveness and suitability factors of potential MRRS alternatives in the AoA and established operational and combat suitability key performance parameters in requirements documents for the MRRS and GWLR. Also, in the request for proposal for G/ATOR, the Marine Corps required contractors to consider the logistical burden of the cooling system.

Analysis of Alternatives. As discussed in the audit response to Allegation 2, the Marine Corps study team used a value model with 51 weighted attributes to evaluate the operational effectiveness and suitability factors of 4 MRRS alternatives in the AoA. Suitability attributes of the potential alternatives

evaluated included electronic protection and electronic countermeasure features, update rates, number and types of vehicles, self-survey and automatic leveling capability, set-up and breakdown, and the mean-time-to-repair.

Operational Requirements Documents. The operational requirements documents for the MRRS and GWLR contained numerous attributes and key performance parameters that addressed the operational and combat suitability requirements for the G/ATOR radar system. On July 20, 2004, the JROC validated the key performance parameters in the MRRS operational requirements document for mobility, deployability, and transportability. A key performance parameter required that the radar system be transportable and deployable by Marine Air Control Group assets and be reconfigurable from transport to full operational mode within 60 minutes by no more than four Marines. In addition, the key performance parameter required that the MRRS be internally transportable by a C-130 aircraft and be capable of external lift by helicopter.

On June 1, 2005, the JROC also validated the key performance parameters in the GWLR capabilities development document for the GWLR to be able to drive on and drive off a C-130 aircraft. In addition, the MRRS operational requirements document and GWLR capabilities development document required that the radars have anti-tamper and technology protection, data integrity, operational availability, remote operation, digital and electronic displays, load and unload without a material handler, safe operation, and embedded simulation.

Ground/Air Task Oriented Radar Performance Specification. In May 2006, the Marine Corps Systems Command issued for Increment I of the G/ATOR program, which includes MRRS, an amended request for proposal for the system development and demonstration phase of the acquisition process. In the performance specification attached to the amended request for proposal, the Marine Corps stated that the design of the cooling system for the radar should consider the logistical burden on the operating forces. It also stated that the design of the G/ATOR should not involve the use of specialized coolant, refrigerant, skill sets, and equipment to operate or maintain the radar in a combat zone or field environment. The performance specification, however, did not require contractors to use a particular type of cooling system or preclude the use of a liquid cooling system.

Improper Personnel Actions

Allegation 4. The complainant alleged that Senior Army and Marine Corps personnel threatened retaliation, reprimand, and loss of promotion opportunity for those wanting to discuss alternative means for meeting radar requirements.

Audit Results. We did not substantiate the allegations. As discussed under the audit results for Allegation 2, senior Army and Marine Corps management, including the Assistant Secretary of the Army (Acquisition, Logistics, and Technology) and the Assistant Secretary of the Navy (Research, Development, and Acquisition) had actively considered alternative means for meeting radar requirements. Further, we found no evidence that senior management had

threatened the employees developing requirements for the MMR and the MRRS. In making this determination, we contacted senior managers, employees, the civilian personnel and advisory center; and the equal employment opportunity office at Fort Bliss, Texas; as well as senior managers, employees, the human resource office, and the equal employment opportunity office at the Marine Corps Systems Command, Quantico, Virginia.

Army and Navy Coordination on Radar Requirements

In April 2005, the Assistant Secretary of the Navy (Research, Development, and Acquisition) solicited the interest and support of the Army for the G/ATOR Program. The Assistant Secretary of the Army (Acquisition, Logistics, and Technology) responded that his staff will continue to actively participate in the Army-Marine Corps Board to merge their multiple-mission radar requirements, to form an agreement to combine technologies, and to establish a joint system. In addition, the Assistant Secretary of the Army stated that he would consider participating in a joint effort when it was feasible for one program to meet the radar priorities and requirements for both Services.

Appendix A. Scope and Methodology

We evaluated the adequacy of the processes the Army and the Marine Corps used to generate requirements for the two new radar systems. We reviewed MMR and MRRS requirements documents, budget, and threat documents dated from March 1996 through September 2006. We interviewed personnel from the Office of the Joint Chiefs of Staff, the Army DCD, the Army Intelligence and Information Warfare Directorate, and the Marine Corps Systems Command to identify the processes used to generate requirements and to obtain requirement, threat, and background documentation.

We performed this audit from March 2006 through October 2006 in accordance with generally accepted government auditing standards.

Use of Computer-Processed Data. We did not use computer-processed data to perform this audit.

Use of Technical Assistance. Two electrical engineers and one computer engineer from the Electronics Engineering and Software Engineering Branches, Technical Assessment Directorate, Office of Deputy Inspector General for Policy and Oversight, Department of Defense Office of Inspector General assisted in the audit. The engineers assisted the audit team by determining whether the requirements for the MMR and the G/ATOR were similar enough to develop a joint radar system rather than two separate radar programs.

Government Accountability Office High-Risk Area. The Government Accountability Office has identified several high-risk areas in DoD. This report provides coverage of the DoD Weapons Systems Acquisition high-risk area.

Prior Coverage

No prior coverage has been conducted on the acquisition of the Army Multi-Mission Radar or on the Marine Corps Multi-Role Radar System during the last 5 years.

Appendix B. DoD Requirements Process for Weapon Systems

The following paragraphs describe the top-down capabilities identification methodology that DoD uses within the JCIDS process to assess military capability needs and to support starting the Defense acquisition management process. The paragraphs also provide a brief overview of the Defense acquisition management process.

Top-Down Capabilities Identification Methodology

The Chairman of the Joint Chiefs of Staff Instruction 3170.01E, "Joint Capabilities Integration and Development System," May 11, 2005, defines the process DoD uses to identify, assess, and prioritize joint military capability needs. The JCIDS process begins with the top-down capabilities identification methodology, which occurs before the start of the Defense acquisition management process. The top-down capabilities identification methodology is a capabilities-based assessment and consists of a structured, four-step process that draws on the expertise of all Government agencies to identify improvements to current and new warfighting capabilities. This process allows the Chairman of the Joint Chiefs of Staff, with the assistance of the JROC, to assess and provide advice regarding military capability needs for Defense acquisition programs. The four sequential steps include the Functional Area Analysis (FAA), the Functional Needs Analysis (FNA), the Functional Solution Analysis (FSA), and the Post Independent Analysis (PIA). The sponsoring office within a Military Department or DoD agency completes the first three steps, while an independent group completes the PIA.

Functional Area Analysis. The FAA identifies the operational tasks, conditions, and standards needed for defining military objectives, assessing capabilities and attributes, and developing integrated architectures. The operational tasks in the FAA allow the Defense Intelligence Agency to produce an Initial Threat Warning Assessment, which identifies adversarial threats affecting an identified capability.

Functional Needs Analysis. The FNA assesses the ability of existing and programmed joint capabilities to accomplish the operational tasks developed in the FAA. It also evaluates the full range of operating conditions, designates standards identified by the FAA, and further defines the integrated architectures. Using the tasks identified in the FAA, the FNA also produces a list of capability gaps requiring solutions, describes key capability attributes to resolve those capability gaps, and develops measures of effectiveness. Finally, the FNA uses the measures of effectiveness to evaluate how well existing or programmed capabilities support the development of key performance parameters.

Functional Solutions Analysis. The FSA is an operational-based joint assessment that solves one or more of the capability gaps identified in the FNA. The results of the FSA influence the future direction DoD takes on integrated

architectures and provides input to capability roadmaps. Capability roadmaps are plans DoD develops using integrated architectures. DoD uses capability roadmaps to conduct capability assessments, guide system development, and define investment plans. The FSA also contains the Analysis of Material Approaches (AMA). The AMA determines which approach or combination of material approaches best provides the desired capabilities, determines how the approaches align with DoD integrated architectures and capabilities, and identifies potential changes to integrated architectures.

Post Independent Analysis. An independent team prepares the PIA to assess the results of the FSA and its AMA to ensure that the list of potential capability approaches are complete. The independent team then compiles the results of the PIA into an appropriate recommendation to the sponsoring office. The sponsor then uses the results of the PIA, as well as the results of the FAA, FNA, and FSA, to prepare the ICD and a plan for conducting an AoA. The ICD and the AoA plan are required to start the Defense acquisition management process.

Defense Acquisition Management Process

DoD Instruction 5000.2, "Operation of the Defense Acquisition System," May 12, 2003, establishes a simplified and flexible Defense acquisition management process. The Defense acquisition management process is a four-phase process for translating mission needs and technology opportunities (based on approved mission needs and requirements) into stable, affordable, and well-managed acquisition programs. The four phases include concept refinement, technology development, system development and demonstration, and production and deployment. The program manager and the milestone decision authority are required to structure a tailored, responsive, and innovative program. Progress through the acquisition life cycle depends on obtaining sufficient knowledge to continue to the next stage of development.

Concept Refinement Phase. The concept refinement phase, which begins with the concept decision, is the first phase in the Defense acquisition management process. Entrance into this phase depends upon having completed the JCIDS top-down capabilities identification methodology, having an approved ICD, and a plan for conducting an AoA. The ICD describes capability gaps that exist in joint warfighting functions and identifies potential material approaches to addressing those gaps. The AoA assesses the critical technologies associated with technology maturity, technical risk, and other concepts to achieve the best possible system solution. During the concept refinement phase, the sponsoring office refines the initial concept and develops a technology development strategy. The concept refinement phase ends at acquisition Milestone A, the technology development decision, when the milestone decision authority approves the preferred solution resulting from the AoA and approves the associated technology development strategy.

Technology Development Phase. The technology development phase is the second phase in the Defense acquisition management process and begins at the acquisition Milestone A decision. During this phase, the sponsoring office

reduces technology risk and determines the set of technologies to be integrated into a full system. In addition, the sponsoring office prepares a capability development document to support program initiation, refine the integrated architecture, and clarify how the program will lead to joint warfighting capability. The capability development document builds on the ICD and provides key and detailed performance parameters necessary to design the proposed system. The project exits technology development when an affordable increment of militarily useful capability has been identified, the technology for that increment has been demonstrated in a relevant environment, and the system can be developed for production within a short time frame. Acquisition Milestone B, the system development and demonstration decision, follows the completion of the technology development phase.

Final Two Phases of the Defense Acquisition Management Process. The system development and demonstration phase is the third phase in the Defense acquisition management process and begins at the Acquisition Milestone B decision. By the Acquisition Milestone B decision, the program manager is assigned and the milestone decision authority formally establishes an acquisition strategy. The milestone decision authority also approves the exit criteria the program manager must achieve to go into the fourth phase of the acquisition process, production and deployment. The program manager then takes the system through low-rate initial production and, finally, full-rate production. During full-rate production, the program manager delivers the system to the warfighter.

Appendix C. Report Distribution

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition, Technology, and Logistics
    Director, Acquisition Resources and Analysis
Under Secretary of Defense (Comptroller)/Chief Financial Officer
    Deputy Chief Financial Officer
    Deputy Comptroller (Program/Budget)
Director, Program Analysis and Evaluation
Director, Defense Procurement and Acquisition Policy

Department of the Army

Commanding General, U.S. Army Training and Doctrine Command
Assistant Secretary of the Army (Acquisition Logistics and Technology)
Auditor General, Department of the Army

Department of the Navy

Assistant Secretary of the Navy (Research Development and Acquisition)
Naval Inspector General
Auditor General, Department of the Navy
Inspector General, Marine Corps
Commanding General, Marine Corps System Command

Department of the Air Force

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Non-Defense Federal Organization

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Congressional Committees and Subcommittees, Chairman and Ranking Minority Member

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Senate Subcommittee on Defense, Committee on Appropriations
Senate Committee on Armed Services
Senate Committee on Homeland Security and Governmental Affairs
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House Committee on Armed Services
House Committee on Government Reform
House Subcommittee on Government Management, Finance, and Accountability, Committee on Government Reform
House Subcommittee on National Security, Emerging Threats, and International Relations, Committee on Government Reform

Team Members

The Department of Defense Office of the Deputy Inspector General for Auditing, Acquisition and Contract Management prepared this report. Personnel of the Department of Defense Office of Inspector General who contributed to the report are listed below.

Richard B. Jolliffe
John E. Meling
Harold C. James
Andrew D. Greene
Nathan R. Witter
Breon E. Dehoux
Douglas W. Slaughter
Caryn M. Chambers
Jaime A. Bobbio
Wei K. Chang
Menh Q. Tran
Meredith H. Johnson

Inspector General
Department of Defense